Unprecedented Technological Trends Push the Envelope in Life Sciences

A preview of five pivotal technology trends remaking the life sciences industry: AI and automation, human augmentation, edge analytics/processing, data ownership and protection, and the intermingling of products and services.

Executive Summary

A group of emerging technologies is rapidly creating numerous opportunities for life sciences companies to improve productivity, enhance patient care and ensure regulatory compliance. These technologies include robotic process automation (RPA), artificial intelligence (AI), machine learning (ML), blockchain, the Internet of Things (IoT), 3-D printing and augmented reality/virtual reality (AR/VR). This white paper, built from an earlier report, “Unexpected: Five Ways Technology Will Challenge Conventions,” explores five themes encompassing key technological advances and evolving business models that are transforming the life sciences industry.

Our first theme, Blur, uncovers how medicinal products are being combined with value-added services such as patient engagement, education and compliance tools, to generate data and thus provide greater insights on patient lifestyle and user experience. We also examine value-based healthcare, a new business model that supports this product-plus-service paradigm and focuses on patient outcomes. Value-based is emerging and replacing the old volume-based model of healthcare.
In *Know Me, Forget Me*, we explore how freely we give up our personal data, expecting that doing so will be to our advantage. But our data could also be used without our knowledge, monetized without our approval or even used against us. We must become more aware of how our personal information is used, and take control by ensuring that it will be “forgotten” once it no longer benefits us.

*Excellence at the Edge* is about extracting the value of data while it is freshest and most relevant. Data collected at the network’s edge by IoT devices, wearables and mobile apps can be processed, analyzed and acted upon in real time — enabling life sciences companies to work smarter, respond faster and be better informed in making vital decisions.

As automation and AI become increasingly mainstream, life sciences companies have an opportunity to differentiate themselves from the competition by being early adopters. *Automation at Work* explores the opportunities created in the areas of patient care, drug discovery and business process automation by emerging automation and AI technologies.

In *Augmented Humanity*, we see how technology is helping those afflicted with serious injury, hereditary disease or disability to walk, see or express themselves. With these advances, digitally-augmented humans are living fuller lives and increasing their lifespans.
BLUR

A pill used to treat a condition can now self-report that it’s reached your stomach. A watch worn to display time can now monitor your sleep patterns and vital signs, and transmit them via Bluetooth to your smartphone and then to your care provider (with your consent), who can then review in real time and recommend a course of action or treatment.

As healthcare costs skyrocket, the industry has begun to shift toward value-based care. This, combined with rising consumerism and increased adoption of digital technology, is pushing pharmaceutical companies to deliver support and services directly to the consumer. This gradual shift has given rise to new paradigms such as patient-centricity, “beyond the pill” and “around the pill,” where medicinal products are combined with value-added digital services enabled through emerging technologies.

As such, life sciences companies are pivoting from being purely product-based entities to product/services players that improve patient outcomes.

Product Plus Digital Service: The New Paradigm

Pharma companies are embracing more patient-centric approaches by engaging directly with patients to better understand their needs and the challenges that they face, and in turn by providing patients with better information and support. Digitization has helped pharma companies augment products by creating patient engagement services that inform, engage and support patients in the care journey. This is upending the traditional business model of volume-based care, and replacing it with value-based care.

A few examples of services that pharma companies have begun to provide patients that go “beyond the pill” include patient engagement solutions that enable quick and efficient onboarding, assistance with reimbursements, outreach and personalized services (including guidance on treatment programs), adherence reminders/alerts, and support systems in case of adverse side effects or reactions to a drug.

For instance, one leading pharmaceuticals company selling a rheumatoid arthritis drug found

Figure 1
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through surveys and discussions that patients were often anxious upon receiving a prescription for its Rx, since obtaining and administering the drug presented several challenges. There was often a delay in receiving the drug; it came with a high out-of-pocket expense; patients often feared injecting the drug; and many were concerned with its potential adverse side effects.

To respond to these challenges, the company adopted a “beyond the pill” approach. It created an ecosystem of patient-centric services that included a more efficient onboarding process and direct training from nurses on how to take the injectable. It also extended to a one-touch support system that was made available to patients who experienced adverse side effects or reactions to the drug.

Other “around the pill” digital services include physician-prescribed clinical apps encompassing a variety of companion health applications and devices that serve as digital therapy. Apart from providing a mechanism to treat patients, they also collect patient health metrics and help care professionals “close the loop” with their patients.

One example of such a clinical app is BlueStar, which is prescribed by a healthcare provider (HCP) to support the management of type 2 diabetes. Cleared by the FDA in 2013, the app was the first mobile prescription therapy in the U.S.; the FDA approved its non-prescription version in 2017. Developed for adults living with type 2 diabetes, BlueStar analyzes diabetes data entered by the patient (including blood glucose levels), compares trends, delivers summarized curated data and suggests a plan for self-management.

**KNOW ME, FORGET ME**

Patients’ lives are being made easier already by devices such as wearables and IoT medical sensors. One day, your watch may wake and alert you to high blood sugar levels. You’ll then use a smartphone app to instantaneously book an appointment with your physician. When you arrive at your doctor’s office, your tests will already be scheduled and performed on the spot. By the time you get home, your phone is vibrating with a notification that your test results are ready. After dinner, you jump on a video call with your HCP to review the results and discuss treatment options (see Figure 2).
A collaborative and consent-based approach that apprises patients well in advance of the use of their PHI collected at trials helps ensure both transparency and their active participation.

As such, *Know Me, Forget Me* reveals patients’ acceptance that it’s OK to monitor them and collect their data in order to provide an immersive experience. The critical factor here is that patients expect to be forgotten on their terms, typically once they no longer believe they are receiving value in return. What’s key is that they expect their providers to make sure their data is safeguarded from falling into the wrong hands.

The issue of data privacy and security is very important in life sciences, as pharma companies collect volumes of highly sensitive patient data including protected health information (PHI). This data is collected during clinical trials and post-marketing surveillance for safe and effective treatment, and it needs to be secured.

As part of patient engagement, pharma companies now capture and monitor information related to lifestyle, vital signs and medical history. This raises serious questions and concerns about data privacy.

The success of pharma companies depends upon their ability to leverage the huge treasure trove of patient and healthy individual data in a transparent and secure manner that does not compromise the individual’s privacy and security in any manner.

**Giving Control**

Advanced technologies such as wearables, sensors and mobile apps are empowering patients to take control of their health. A collaborative and consent-based approach that apprises patients well in advance of the use of their PHI collected at trials helps ensure both transparency and their active participation. At the same time, patients need to take responsibility for their personal data which means taking the necessary precautions and using judgement before sharing such data on social media and mobile apps.

Regulatory and governmental bodies have been at the forefront of data privacy, protection and security in life sciences. The Healthcare Insurance Portability and Accountability Act (HIPAA) protects the privacy and security of an individual’s PHI and ensures it cannot be disclosed without the individual’s consent. But the threat to patient privacy and data security has increased exponentially since HIPAA was passed in 1996 due to digitization and the advent of cloud, mobile, social and wearables. According to healthcare statistics published by *HIPAA Journal*, data breaches have soared over the past nine years, with 2017 seeing more data breaches reported than any other year.\(^6\)

Technological advances are creating new ways to share and protect data. For example, sharing of genomic and clinical trial data is now possible by using blockchain technology.\(^7\) With blockchain, sensitive patient data can be concealed while at the same time be used for studies and shared across companies without compromising patient privacy.
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EXCELLENCE AT THE EDGE

Various forms of data, whether structured or unstructured, historical or real-time, hold great significance in any industry. In life sciences, data has the potential to completely change the way treatment is provided to patients. Imagine a scenario where a robot diagnoses a disease and prescribes a personalized medicine on the basis of the patient’s genetic make-up (genome sequence) and past medical history. The patient uses a 3-D printer at his or her home to create the medicine. The chip in the medicine tracks when the pill is taken through the patient’s smart phone and the smart watch tracks vital signs post medication, sending real-time updates to the virtual patient assistant throughout the treatment journey.

Advances in analytics and cloud adoption, coupled with data collected by wearables, devices and mobile apps, are making huge amounts of patient data available in real time, enabling pharma companies to improve patient care and safety. Excellence at the network’s edge is all about collecting, processing and analyzing data as close as possible to its source, processing in the cloud to gain valuable business insights and acting upon those insights in real time.

Remote Patient Monitoring

Numerous wearable devices and sensors are available today that allow continuous, real-time monitoring of key patient vital signs such as heartbeat, temperature and blood pressure. They enable HCPs to remotely monitor and assess patients’ condition.

The evolution of edible sensors and chips has enabled the development of smart pills. Smart pills are currently being used to track drug ingestion and activity levels. In the near future, pills with miniature chips will help monitor human organs and vital signs such as blood sugar levels, body temperature, blood pressure and pH levels, and transmit such data, in real time, to the care provider.

Data Monetization

Life sciences is a data-intensive industry, and pharma organizations have an enormous amount of historical scientific and research data collected over many years. This real asset presents an opportunity to find new drug candidates and repurpose existing drugs. Sensing the magnitude of opportunity, many leading pharma organizations share clinical trial data with the public, allowing researchers to combine data from multiple sponsors/organizations to innovate and accelerate clinical research. For example, GlaxoSmithKline has been sharing information about clinical research with the public as part of its data transparency initiative.

Another area of focus is to identify new treatments tailored to an individual’s genetic makeup, environment and lifestyle. Advances in genomics research, coupled with data sciences, AI and advanced analytics, are enabling further scientific and medical research in the area of precision/personalized medicine. Organizations in the U.S. and UK have launched initiatives to collect human genome data for the advancement of research into better diagnostics and personalized care.
Business Insights

Apart from data monetization, advances in analytics and data sciences are driving prescriptive and predictive insights that help assess the effectiveness, safety and economic outcome of drugs, improve clinical trials efficiency, streamline the supply chain and increase sales force effectiveness. Business scenarios where these techniques are applied to derive real time, meaningful insights include:

- **R&D:** Clinical trial status, patient safety, patient recruitment, site identification and optimal trial design.

- **Manufacturing and supply chain:** Enhanced production planning based on demand projection; complex supply chain management, including predicting supply risk based on vendor performance.

- **Commercial:** Sales force planning and alignment, market access and contracting strategy.

To make the most of this opportunity, companies must acquire skills in advanced analytics and data sciences and build functional data lakes.

AUTOMATION AT WORK

Automation and AI are emerging agents of change that are rippling across all industries, from autonomous cars and robots on the factory floor through digital assistants in the office and software bots.

In the life sciences industry, automation and AI provide the opportunity to transform the patient or user experience through conversational chat bots, speed up drug discovery by applying AI and automate standard, repeatable, rules-based business processes.

Transform User Experience

Voice is the new user interface, and AI-based conversational bots are being embraced by life sciences companies to enhance experience for patients, healthcare professionals and internal users. These bots take the form of digital or virtual assistants for users such as patient assistants (voice-based bots that guide patients through the treatment journey) or lab assistants (conversational bots that help scientists in labs to perform experiments). A number of voice-based chat bots have been deployed by life sciences companies. For example, we developed a voice-based chat bot that interacts with end users and helps to resolve IT issues.

Digital Patient Assistants

![Image of digital patient assistants](image-url)

Figure 3
Augmented and virtual reality technology, which provides immersive experiences by simulating real-world environments through headsets, is being adopted to create educational, training and promotional material for both patients and HCPs. For example, we have developed an AR/VR-based training solution that illustrates how insulin behaves when injected into the human body (see Figure 4).

Reimagine the Process

While there has been plenty of computer system-based automation over the years, an abundance of business activity is still carried out manually, resulting from a lack of integration among systems and data extraction from source documents. Advances in RPA technology coupled with natural language processing (NLP) now provide the capability to automate standard, repeatable and rule-based business activities.

Numerous business functions such as procurement, finance and accounting, talent management, clinical data management and pharmacovigilance require routine manual activities and human intervention before higher-level thinking and action can begin. By automating these manual process end to end, pharma companies can free up resources (both financial and human) for more productive activities.

Pharmacovigilance, for example, is a highly manual and resource-intensive process involving safety case intake, receipt, registration, data entry, quality check, medical review and submission. Adverse events are reported across the globe in multiple languages and formats and in structured, unstructured and handwritten documents from affiliates, partners and distributors.

While there are IT systems and applications that automate case processing and reporting activities, the overall process still requires much human intervention and manual effort, especially in the areas of case intake and data entry. The complete process, from case receipt to reporting, can now be automated using RPA and NLP, thereby limiting the amount of human intervention needed for exception handling, quality checks and reviews.

AI-Based Drug Discovery

Strong forms of AI such as machine learning (ML) have the potential to transform drug discovery. Pharma companies are using AI to identify potential new drug candidates, find new uses for previously identified compounds, predict the performance of drugs during testing and develop personalized medicine based on genetic markers. Some pharma companies are aligning with AI giants and start-ups to unlock the potential of AI in drug discovery; for example, GlaxoSmithKline recently signed a deal with Exscientia.  

Insulin Molecule Journey

![Education via immersive experiences](image)
AUGMENTED HUMANITY

Advances in medical science coupled with technologies such as 3-D manufacturing, smartphones, wearables and sensors are creating new opportunities for improved human capabilities. These smart technologies are either embedded in, worn or carried by people, and they provide significant potential for life sciences.

Augmented humanity refers to the use of technology to augment and enhance human attributes. The term was coined by ex-Google CEO Eric Schmidt in 2010. In life sciences, augmentation can be used to help HCPs in diagnosis and provide better and novel approaches for treating patients.

Augmented Diagnosis

Mobile apps that allow users to search and find drug information and interactions, calculate body mass index (BMI) or check basic symptoms have been available for quite some time. Now, more advanced solutions for disease diagnosis are being built for areas such as oncology. These solutions incorporate advanced AI and machine learning algorithms that are trained using patient data collected over the years.

A smartphone app can today analyze a photo of a rash, mole or coloration and augment the availability and capability of a dermatologist to detect cancer. Similarly, an app can augment the capabilities of ophthalmologists, particularly in underdeveloped areas of the world, by rapidly screening for diabetic retinopathy using fundus photographs of patients’ retinas (see Figure 5).

Augmented Patient

Prosthetics and exoskeletons help those who have been paralyzed or have lost limbs to stand and move again. Advances in neuro-technology continue to improve the lives of those who have suffered a brain injury or have a debilitating disease such as Alzheimer’s or Parkinson’s. This technology is also being applied to improve memory, sharpen cognitive skills and accelerate learning. Brain-computer interfaces (BCIs) link the commands of our thoughts to devices that take action and have the potential to correct disabilities, enhance communications and augment normal human brainpower.

For example, in 2009 Mattel partnered with NeuroSky to develop one of the first commercial brain wearables. The device was an EEG headset that could be used to play a game called Mindflex.

Diabetic Retinopathy Detection Using Deep Learning Algorithms
Pharma, med-tech and digital companies must continue to team up, combine their strengths and make investments in innovative products that blur the line between drug, device and digital service, allow patients to be known or forgotten on demand, provide real-time insights at the edge of the network, free scarce knowledge workers to focus on the highest level of thinking and augment the weaknesses of the human condition.

in which users move a ball around a small obstacle course using their “brainpower.”

Eventually, 3-D printers will create customized organs, tissues and various body parts to replace defective or deteriorating ones. Smart lenses will further help the blind and those with impaired vision to see again or see more clearly. Hearables will allow us to hear the faintest sounds, or translate foreign languages in real time. Implanted chips and digital tattoos will store our personal details and keep them safe.

THE WAY FORWARD

Emerging digital technologies are fueling innovation and transforming the life sciences industry by introducing new business models, products and services and enhancing patient experience. As always, these technologies are unlocking great opportunities as well as enormous risks.

Life sciences companies will need to speed decision-making before adopting new technology to keep pace with more nimble, fast-paced, digital-savvy players who are beginning to pose a threat by introducing technology-enabled new business models. Pharma and medical devices companies must establish a formal innovation group and framework for identifying disruptive technologies within and outside of the life sciences industry, analyzing the potential business impacts and prioritize adoption. From there, we believe this type of collaboration would be instrumental in building an ecosystem of academia, vendors and start-ups to help accelerate new technology adoption. This framework is critical for the survival and sustenance of business in the digital world.

Pharma, med-tech and digital companies must continue to team up, combine their strengths and make investments in innovative products that blur the line between drug, device and digital service, allow patients to be known or forgotten on demand, provide real-time insights at the edge of the network, free scarce knowledge workers to focus on the highest level of thinking and augment the weaknesses of the human condition.
FOOTNOTES


9. “FDA approves pill with sensor that digitally tracks if patients have ingested their medication,” FDA, November 2017; www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm584933.htm.


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ABOUT THE AUTHOR

Harpreet Kanwar
Chief Technology Officer, Cognizant Life Sciences

Harpreet Kanwar is Chief Technology Officer within Cognizant’s Life Sciences business unit. He is responsible for driving innovation, emerging technology adoption, architecture enablement and governance. Harpreet currently focuses on helping life sciences companies adopt automation, AI/ML/NLP/deep learning and blockchain technologies. He has over 25 years of IT industry experience covering consulting, pre-sales and delivery. Harpreet can be reached at Harpreet.Kanwar@cognizant.com.
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